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UPDATING THE IM-5016 WIDE-RANGE GAMMA SURVEY METER

by

P.C. East and M.A. Periard

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Nuclear Effects Section
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ABSTRACT

This note describes a number of modifications to the IM-5016 low-range radiacmeter. The range has been extended to two three-decade scales, 0.1 to 100 mR/h and 0.1 to 100 R/h with automatic range changing. The modified instrument is powered by a single "D" size cell.

RESUME

Le présent rapport a pour but de présenter quelques modifications au radiamètre IM-5016. La gamme de mesure est plus étendue, ayant deux échelles de lecture de trois décades, soit de 0.1 à 100 mR/h et de 0.1 à 100 R/h. L'échelle est déterminée automatiquement par l'appareil et la lecture se fait à l'aide d'une diode photogéne clignotante. L'appareil est alimenté par une pile 1.5 V de type "D".

INTRODUCTION

The IM-5016 is a low-range gamma survey meter that has been in service with the Canadian Forces for over 10 years. This instrument measures gamma dose rates from 1 mR/h to 10 R/h on two quasi-logarithmic scale ranges: 1 mR/h to 100 mR/h and 0.1 R/h to 10 R/h. A commercial version of this instrument is used by the Emergency Planning Candada and by industry in Canada and abroad. While this instrument has been successful it does have a number of limitations: -

1. The military version uses an expensive mercury battery originally required to meet the low-temperature requirement.

2. To cover a range of four decades mechanical range switching is used.

3. With two logarithmic scales there is the possibility of the operator introducing a gross error due to reading the wrong scale.

4. A mechanical offset in the meter zero, due to mechanical shock or temperature cycling, can introduce large scale errors.

A digital meter has been described (1) which overcomes these limitations. Unfortunately this instrument is relatively expensive and there are objections (2) to the use of a digital readout in a portable survey meter because of the difficulty in interpreting the readings when moving about in a non-uniform field.

This note describes a modification to the IM-5016 which: -

1. Converts the circuit to single "D" cell operation.

2. Changes the range automatically.

3. Increases each range to three decades, 0.1 mR/h to 100 mR/h or 0.1 R/h to 100 R/h, and aligns the scales so that only one set of gradations is required.

4. Adds a red light-emitting diode to the meter scale plate which flashes whenever the circuit switches to the high range.

These modifications should be commercially attractive for small-scale production and could be used to update existing IM-5016's. A photograph of a modified instrument is shown in Figure 1.

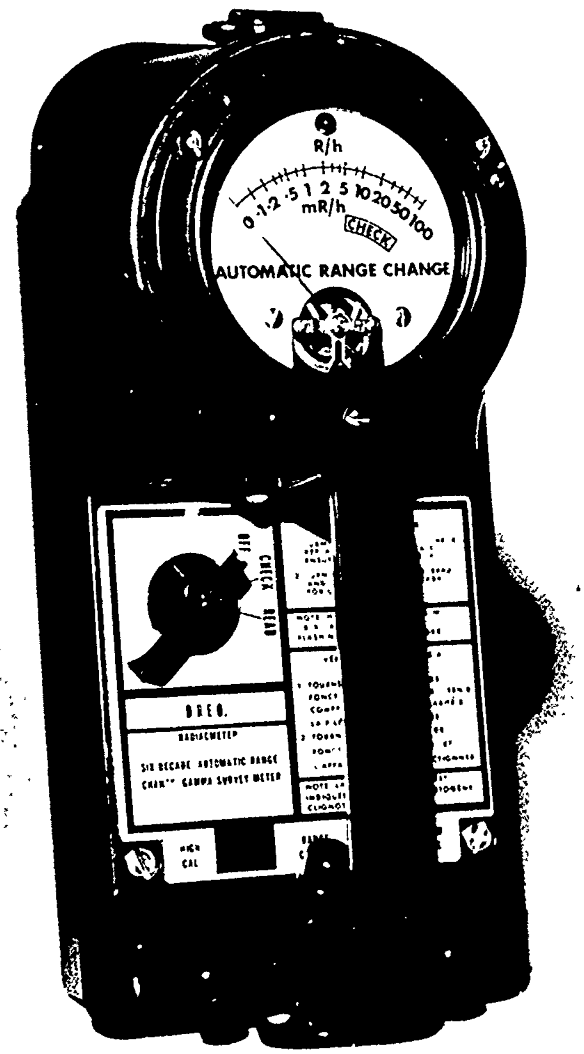

Figure 1. Photograph of Modified IM-5016

CIRCUIT DESCRIPTION

The circuit diagram is shown in Figure 2. For dose rates below 100 mR/h the circuit is on the low range and both G-M tubes are operating. The low-range tube, an 18506 has a nominal count rate of about 6 c/S at 1 mR/h. The G-M tube output pulses are fed via transistor switch Q1 to amplifier Q2, Q3. Transistor Q3 drives transistors Q4 to Q7. This is a variation of the diode pump circuit (3), so that condensors C1 to C4 are discharged by each G-M tube pulse. The charging current to C1, and C3 provides the meter current over the three decades of dose rate. The fourth stage, C4, produces a significant meter current only near full scale and provides compensation for the dead-time losses of the G-M tubes.

Range switching is controlled by flip-flop F1 and is normally set to the low range unless both F1 and F2 are clocked by gate G6. Gates G3, G5 and G6 are connected to counter C1 so that G6 will clock F1 and F2 after 112 pulses from the high-range G-M tube, an 18529. The 18529 has a nominal count rate of 35 c.s at 0.1 R/h or 112 counts in approximately 3 seconds. With F1 clocked: -

1. Transistor Q1 is off and the low-range G-M tube is off.
2. Transistor Q9 is off and Q8 is on connecting the high-range calibration potentiometer across the meter.
3. Gate G12 is on and the high-range LED indicator flashes.
4. Gate G5 is off so that F1 and F2 are clocked after 96 counts in each timing cycle or 86 mR/h.

With F2 clocked, gate G8 is off and the timing circuit cannot set F1 to the low range. If the dose rate falls below 86 mR.h, F2 will not be clocked and at the end of the timing cycle F1 is set to the low range.

The count rate of the high-range tube is about six times that of the low-range tube for the same scale reading. Gates G1 and G2 pass the first three of each four pulses from the Q2 output of counter C1, thus the output of G2 feeds the high-range G-M tube pulses divided by 16/3 to the pump circuit.

POWER SUPPLIES

The circuit diagram of the power supply is shown in Figure 3. The 9-volt supply must be well regulated since the meter current is directly proportional to it and a 1% change in the meter current will cause a 10%

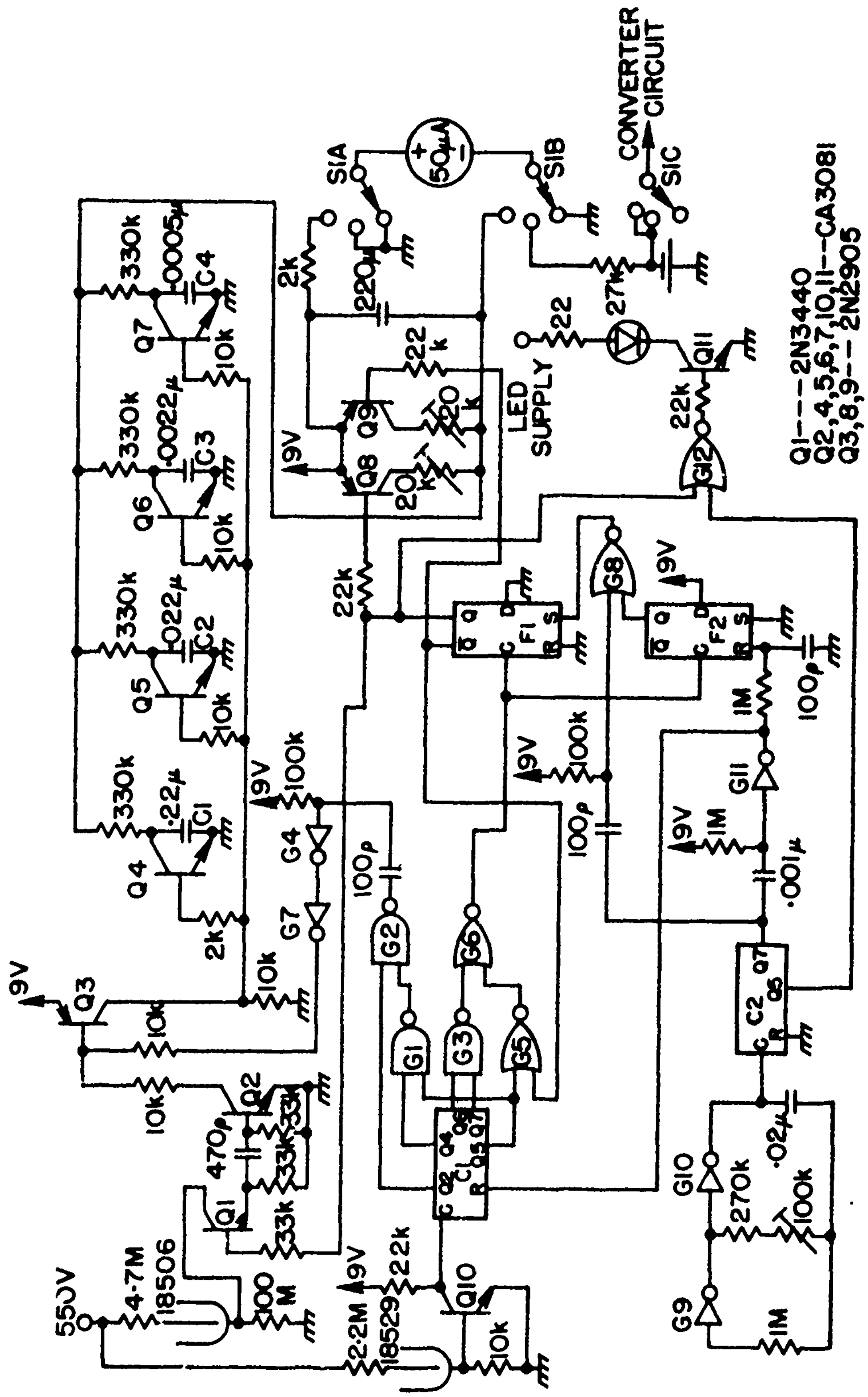

Figure 2. Circuit Diagram

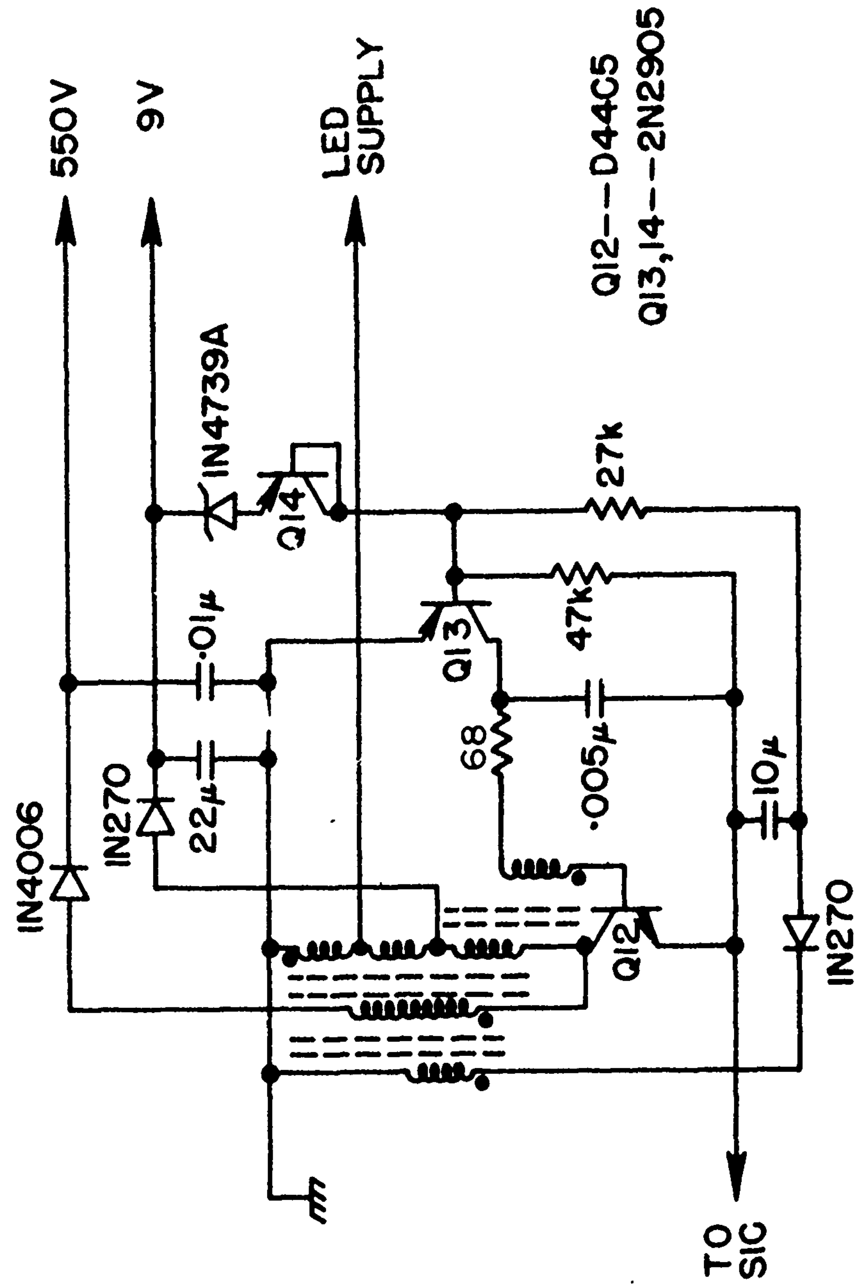

Figure 3. Converter Circuit

change in the scale reading on a three-decade logarithmic scale.

The circuit is regulated by a Zener diode fed by an essentially constant current and there will be negligible variation in the 9-volt supply over the useful life of the battery at room temperature. With change in temperature, the 9-volt supply will vary due to the temperature coefficient of the Zener diode. The base-emitter voltage variation of Q13 is compensated by transistor Q14, strapped as a diode.

The LED is fed directly from a tap on the collector winding and is on during the oscillator transistor Q12 off-time. For a constant output voltage and load, this off time is constant. To supply this load the collector current of Q12 and its on time must increase as the battery voltage drops. Thus the average current to the LED reduces as the battery voltage drops. For adequate brightness at low battery voltage, there is wasted power at higher voltages. This is preferred to the constant loss in a rectifier plus the cost of a diode and a condenser.

The zinc-carbon cell should provide over 40 hours of continuous operation at moderate temperature. To meet the low-temperature requirements the lithium cell must be used.

PERFORMANCE

The performance of this instrument will be similar to that of the IM-5016.

The detectors, the detector housing and location are unchanged, so that the energy dependance and directional characteristics will be as described for the IM-5016 (4).

The scale accuracy requirement of $\pm$ 20% should easily be met over the four decades 1 mR/h to 10 R/h. For dose rates below 1 mR/h the accuracy will be limited by poor statistics and for dose rates above 10 R/h the errors may be aggravated by the difference in the dead-time errors of the two G-M tubes.

The circuit is relatively insensitive to temperature change. The meter circuit is arranged so that its change in sensitivity due to the 0.4% ^{0}C temperature coefficient of the meter resistance compensates for the change in the 9-volt supply due to the temperature coefficient of the Zener diode, typically 0.6%^{0}C. Temperature errors should be less than $\pm$10%.

REFERENCES

1. A Digital, Dual-Range, Portable Gamma Survey Meter Incorporating Dose Measurement. P.C. East and M.A. Periard. DREO TN 76-29

2. Private Communication. M. Walsh, Central Health Physics, Ontario Hydro. 1976

3. Transistor Circuit Design for a Radioactivity Contamination Meter. F.S. Goulding, Atomic Energy of Canada Ltd. Feb. 1957. AECL Report CREL-605

4. Production Approval Testing of Radiacmeter, Gamma Survey, Low Range, IM-5016/PD R.H. Panther, DAEL Feb. 1966

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